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| Technical Report | |
| 3rd Generation Partnership Project;  Technical Specification Group TSG SA;  Study on Upper layer traffic steer, switch and split over dual 3GPP access  (Release 19) | |
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# Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# 1 Scope

[This document….]

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] HARAMAIN: Train of the desert (https://www.eltrendeldesierto.com/)

…

[x] <doctype> <#>[ ([up to and including]{yyyy[-mm]|V<a[.b[.c]]>}[onwards])]: "<Title>".

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

**example:** text used to clarify abstract rules by applying them literally.

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

<ABBREVIATION> <Expansion>

# 4 Overview

Editor’s Note: intends to provide a general overview of target scenarios/use cases, main assumptions/options and other general aspects of the TR. May include high-level diagrams/figures, to illustrate connectivity concepts.

# 5 Use cases

## 5.1 Use case on dual 5G satellite access in maritime scenario

### 5.1.1 Description

This use case describes a scenario where an autonomous ship is remotely controlled from shore. The ship has a UE that is served by two satellite RANs (GEO and LEO) belonging to the same PLMN that is managed by a 5G satellite operator. The ship UE has a single PLMN subscription.

Dual 5G satellite access is applied to accommodate high amount of data traffic for remote control operations. For better performance of the autonomous ship operations, the delay sensitive applications (e.g. remote control operations, collision/accident prevention, emergency management, etc.) use LEO satellite link as it has smaller UE to ground propagation delay than GEO satellite connection (max 30 ms for LEO vs max 280 ms for GEO, TS 22.261 clause 7.4.1). Other applications (i.e. delay tolerant, such as sensor data monitoring, video surveillance, etc.) may use GEO satellite link or aggregate the traffic over both accesses.

### 5.1.2 Pre-conditions

The autonomous ship called as KASS (Korean Autonomous Surface Ship) supports dual 5G satellite access (GEO and LEO).

The UE installed on KASS has a subscription for using GEO and LEO satellite services of a 5G satellite operator.

The UE installed on KASS is registered and connected to GEO and LEO satellites RANs.

Based on the service agreement between the KASS managing company and the 5G satellite operator, the 5G satellite network has the following policies for the UE on KASS:

* The data traffic of delay-sensitive applications is routed via LEO satellite link whenever it is available.
* The data traffic of delay-tolerant applications is aggregated via both LEO and GEO satellite links.

### 5.1.3 Service Flows

1. KASS is in the ocean and is being remotely controlled by the shore control center. KASS has two active data sessions – one for remote control operation and the other for KASS’s sensors data monitoring. As per the agreed policies, the traffic of remote control operation (delay-sensitive) is being routed via LEO satellite link and the traffic of sensors data monitoring (delay-tolerant) is being aggregated via both LEO and GEO satellite links.

Diagram

Description automatically generated

Figure 5.1.3-1: Dual 5G satellite access for autonomous ship operations

1. The LEO satellite access becomes unavailable (e.g. due to loss of line of sight between the UE and a satellite). Therefore, all the traffic that was routed via the LEO satellite access is moved to GEO satellite access, while the continuity of data sessions is maintained. The application for ship remote control (delay-sensitive) detects increased communication latency, so it adapts its operations accordingly.

Diagram

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Figure 5.1.3-2: Traffic switching due to loss of connection with LEO satellite access network

1. After a while, the LEO satellite access becomes available again. Therefore, the traffic distribution across two satellite accesses is returned to the state as in Step 1.

### 5.1.4 Post-conditions

The remote shore control centre controlled KASS throughout its route and KASS successfully reached its destination.

### 5.1.5 Existing features partly or fully covering the use case functionality

ATSSS feature specified in TS 23.501 clause 5.32 supports dual user plane connectivity between a UE and a data network using one 3GPP access network and one non-3GPP access network.

From TS 22.261:

Based on operator policy, the 5G system shall be able to dynamically offload part of the traffic (e.g. from 3GPP RAT to non-3GPP access technology), taking into account traffic load and traffic type.

Based on operator policy, the 5G system shall be able to provide simultaneous data transmission via different access technologies (e.g. NR, E-UTRA, non-3GPP), to access one or more 3GPP services.

When a UE is using two or more access technologies simultaneously, the 5G system shall be able to optimally distribute user traffic over select between access technologies in use, taking into account e.g. service, traffic characteristics, radio characteristics, and UE's moving speed.

The 5G system shall support UEs with multiple radio and single radio capabilities.

The 5G system shall be able to provide services using satellite access.

A 5G system with satellite access shall support different configurations where the radio access network is either a satellite NG-RAN or a non-3GPP satellite access network, or both.

### 5.1.6 Potential New Requirements needed to support the use case

[PR 5.1.6-001] The 5G System shall support a mechanism to steer, split, and switch the user plane traffic over two 5G satellite access networks belonging to the same PLMN, where the user plane traffic is anchored in the 5GC.

## 5.2 Use case on Inter PLMN Mobility Scenario

### 5.2.1 Description

Consider an MNO A, offering specific mobile services in targeted areas with a small contiguous footprint. MNO A has an existing business agreement with MNO B (an operator with relatively larger contiguous footprint) which allows MNO A subscribers to roam on MNO B network when MNO A subscribers are outside its own coverage footprint.

When inside the coverage footprint of both MNO A and MNO B, the subscribers primarily use MNO A network for services offered by MNO A. However, MNO A can offer simultaneous connection to both MNO A and MNO B for specific services (e.g.: services requiring high data rates) to its premiere subscribers (“golden subscribers”) to get a higher data rate connection by allowing their data traffic to use an extra NR connectivity link from MNO B (with anchor and aggregation in the MNO A CN). Such functionality is assumed to be supported by both MNOs CNs, UEs (of MNO A subscribers), and is associated with a set of traffic policies and conditions, negotiated by the MNOs, which MNO A can control and provision (for its own subscribers).

When outside the coverage footprint of MNO A (but inside the coverage footprint of MNO B), the MNO A subscribers roam on to the MNO B network. As the MNO A subscriber moves in and out of the MNO A coverage, MNO A CN, should be able to switch traffic between the two networks based on the network availability. (Similar to how current ATSSS functionality can switch traffic between the 3GPP and non-3GPP access after losing connectivity to one of the accesses). When the MNO A subscriber enters MNO A coverage, the traffic can be switched from MNO B to MNO A or traffic can be steered on both networks depending on the service type and subscription tier of the MNO A subscriber.

### 5.2.2 Pre-conditions

Alice is a “golden subscriber” of MNO A, while Bob is a “normal subscriber” of MNO A. Alice’s UE is a dual (NR) radio capable.

Based on their subscriber agreement with MNO A, both Alice and Bob can utilize the MNO A network when inside the MNO A coverage and leverage MNO B network when outside the MNO A coverage (supporting traffic switching for mobility scenarios).

In addition, specific traffic policy for Alice, part of MNO A “golden subscriber” agreement includes the use of dual access based on QoS or traffic type, e.g., for high-quality video-calls (supporting traffic steering and splitting).

### 5.2.3 Service Flows

1) Alice and Bob are currently at their home enjoying breakfast on a Saturday morning while surfing the web. They are inside coverage footprint of both MNO A and MNO B. Both are using single access/link to MNO A.

2) They decide to take a stroll to the farmers market less than 2 miles from their home. While travelling towards the market, they decide to stream music online (using MNO A network). Mid way to the market they move outside the coverage footprint of MNO A and the ongoing data traffic is switched from MNO A to MNO B. Now both are outside the coverage footprint of MNO A (but inside the coverage footprint of MNO B) and continue to stream the music without any interruption using MNO B network.

3) While enjoying their Saturday at the Farmer’s market, Alice gets a call from the office for joining an important call from an offshore client in 30min. Alice and Bob start heading back towards their home. Mid way towards their home they move inside the coverage footprint of MNO A and the data traffic is switched from MNO B to MNO A. Now both are inside the coverage footprint of MNO A (and inside the coverage footprint of MNO B) and continue to stream the music without any interruption using MNO A network.

4) After reaching home, Alice decides to start the video call from her device and starts presenting to the offshore client while her son plays video games, and her daughter is streaming movies on Netflix. Alice being the “golden subscriber”, the traffic is now steered or split across both MNO A and MNO B network enabling a high data rate connection for Alice.

5) The client is satisfied with the presentation from Alice. The call ends and Alice goes back to enjoying her Saturday by streaming music using MNO A network.

### 5.2.4 Post-conditions

Alice’s enjoys seamless connectivity while she moves in and out of the coverage of MNO A.

### 5.2.5 Existing features partly or fully covering the use case functionality

*FFS.*

### 5.2.6 Potential New Requirements needed to support the use case

[PR 5.2.6-001] The 5G system shall be able to support mechanisms to enable steering and splitting of UE’s user plane traffic (of the same data session) across two different PLMNs each having a 3GPP access network (e.g. both using NR) and a 5G core network.

[PR 5.2.6-002] The 5G system shall be able to support mechanisms to enable switching of UE’s user plane traffic (of the same data session) for seamless mobility from one PLMN to a different PLMN, each having a 3GPP access network (e.g. both using NR) and a 5G core network.

NOTE: The above requirements assume a single PLMN subscription and a proper business agreement is in place between the two MNOs, including negotiation of specific traffic routing policies and rules.   
Data traffic is assumed to be anchored in the HPLMNs core network.

## 5.3 Use case on Inter-PLMN or PLMN-SNPN scenario

### 5.3.1 Description

This example scenario refers to a stadium, served by ad-hoc/in-venue 5G NR deployment (high-capacity) from one SNPN or PLMN network (MNO-A), plus 5G NR coverage, from the outside the stadium, by another PLMN (MNO-B). There is no NW sharing in place between the two 5G networks.

A picture containing text

Description automatically generated

**Fig. 5.3-1 Stadium scenario**

The above example may similarly apply to other local premises, e.g., campus, enterprise, mall, factory.

MNO-B has business and roaming partnership with MNO-A, including the agreement to lease extra capacity (from MNO-A) to provide ultra-broadband experience to some of MNO-B “golden” customers. The agreement between MNO-A&B entails the ability for those MNO-B users to get higher data rate connection, by allowing their data traffic to use an extra NR connectivity link from PLMN-A’s (with anchor and aggregation in their HPLMN’ CN). Such functionality is assumed to be supported by both PLMNs’ CNs, UEs (of golden MNO-B users), and is associated with a set of traffic policies and conditions, negotiated by the MNOs, which the HPLMN can control and provision (to UEs and CN entities).

### 5.3.2 Pre-conditions

Alice and Bob are at the stadium, for a music concert of their favourite singer. Alice is a golden subscriber of MNO-B, Bob is a “normal” MNO-B customer.

Both their UEs are camped and registered on MNO-B NW, in Idle.

Alice’s UE is dual (NR) radio capable.

The specific traffic policy for Alice, part of MNO-B “golden user” agreement, includes the use of dual access based on QoS or traffic type, e.g., for high-quality video-calls, otherwise MNO-B single access/link should be used.

### 5.3.3 Service Flows

1) Before the concert starts, both Alice and Bob make a voice call to their best friends, describing the atmosphere at the stadium, and promising to share a video of the concert later. Both use single 3GPP access connectivity (via PLMN-B).

*Diagram

Description automatically generated*

**Fig. 5.3-2 Step-1: Alice & Bob data sessions use single 3GPP access connectivity**

2) After a while, when the concert starts, Alice and Bob decide to start a video call (with their friends), to share their real-time experience (high-quality video settings).   
Alice’s UE registers to NW-A and establishes a dual access connection across the 2 networks.   
Bob’s UE continues to use single access via PLMN-B.

*Diagram

Description automatically generated*

**Fig. 5.3-3 Step-2: scenario with Alice’s data session using dual-3GPP access connectivity**

3) Both Alice and Bob hang up the video-call and continue enjoying the concert.

### 5.3.4 Post-conditions

Alice’s video quality was much better than Bob’s.

### 5.3.5 Existing features partly or fully covering the use case functionality

A) Stage-2&3 include a feature called ATSSS (Access Traffic Steering, Switching, Splitting), e.g., ref to TS 25.301 sec. 5.3.2, which supports functionalities similar to those described in this use case, but limited to 3GPP access plus *non-3GPP* dual access.

B) Existing service requirements, e.g., from TS 22.261 sec. 6.18 and 6.41, capture some general multi-NW connectivity requirements, which do not fully cover or satisfy the specific target use case and functionalities. See some extracts (not exhaustive) listed below:

[Sec. 6.18: Multi-network connectivity and service delivery across operators]

The 5G system shall enable users to obtain services from more than one network simultaneously on an on-demand basis.

For a user with a single operator subscription, the use of multiple serving networks operated by different operators shall be under the control of the home operator.

When a service is offered by multiple operators, the 5G system shall be able to maintain service continuity with minimum service interruption when the serving network is changed to a different serving network operated by a different operator.

NOTE 1: A business agreement is required between the network operators.

In the event of the same service being offered by multiple operators, unless directed by the home operator's network, the UE shall be prioritized to receive subscribed services from the home operator's network.

NOTE 2: If the service is unavailable (e.g., due to lack of network coverage) from the home operator's network, the UE may be able to receive the service from another operator's network.

NOTE 3: QoS provided by the partner operator's network for the same service will be based on the agreement between the two operators and could be different than that provided by the home operator's network.

[Sec. 6.41: PALS]

Based on localized service agreements, the hosting network shall be able to provide required connectivity and QoS for a UE simultaneously connected to the hosting network for localized services and its home network for home network services.

### 5.3.6 Potential New Requirements needed to support the use case

[PR 5.3.6-001] The 5G system shall be able to support mechanisms to enable steering, split and switch of UE’s user plane traffic of one data session across two 5G networks (e.g., both using NR access) belonging to two different PLMN operators (one of which is HPLMN), or between the HPLMN and a SNPN.   
It is assumed that the HPLMN subscription is used to access both networks, data traffic is anchored in the HPLMN and a proper business agreement is in place among the two network operators, including specific traffic routing policies, e.g., based on geographical location, subscription, traffic type.

## 5.4 Use case on Inter-PLMN scenario - TN and NTN

### 5.4.1 Description

This use case describes a ski-mountain environment, where 5G NR (terrestrial) coverage is provided by a certain MNO-A (and other MNOs) in limited populated areas (around hotel/resorts and ski areas), together with 5G NTN coverage by MNO-SAT. MNO-SAT has roaming agreement with MNO-A, including roaming connectivity in remote areas where cellular coverage is not available, plus extra services (on-demand) in joint-coverage areas.

*A close-up of a compass

Description automatically generated with low confidence*

**Fig. 5.4.1 Inter-PLMN scenario, with terrestrial and non-terrestrial coverage**

Company GOLD, owning a transport business in the area, recently switched to MNO-A as their enterprise cellular provider. GOLD employees are provided with dual-mode (TN&NTN) UEs.  
MNO-A offers GOLD employees with a “premium” data connectivity plan, based on a (exclusive) commercial agreement with local MNO-SAT, allowing MNO-A premium users to utilize the NTN network to provide extra capacity in areas with dual coverage, for example during high-season months (known to bring load/congestion peaks on NW-A).

In particular, GOLD users can get higher data rate by aggregating their traffic over both cellular (NR) link and an extra NTN connectivity link via PLMN-SAT (with data anchor and aggregation in PLMN-A’ CN). Such functionality assumes support by the UEs (of GOLD users) and both PLMNs’ CNs. It also comes with a set of traffic policies and conditions, negotiated by the MNOs and under HPLMN control (who can provision specific UE and NW traffic rules).

### 5.4.2 Pre-conditions

Alice is a GOLD employee (MNO-A premium subscriber), spending her days doing delivery/transportation services around the area. She uses her smartphone for VPN connectivity (emails, docs/files transfer, video-calls), plus some sporadic web-browsing (e.g., during breaks, for checking news, watching some YouTube videos, etc.).

Based on MNO-A & SAT agreements, traffic policies are such that Alice’s UE can use “premium” (dual-RAT) connectivity for VPN traffic (only).

Alice’s UE is dual (NR) radio capable, currently camped and registered on PLMN-A, in Idle.

### 5.4.3 Service Flows

Alice is in her car, parked outdoor, right after lunch break.

1. She opens the VPN app on the UE to start some large file data transfer from/to her VPN server (to update the morning delivery tasks and download the ones for the afternoon).   
The UE registers to PLMN-SAT and starts a dual 3GPP network connection. VPN data flows over PLMN-A and PLMN-SAT networks, with anchor in PLMN-A’s CN.

*Diagram

Description automatically generated*

**Fig. 5.4-2 Alice’s VPN data session: dual 3GPP access connectivity, across NR and NR-NTN**

2. While waiting for the file transfer, she opens the (non-VPN) web-app to read some news. Non-VPN data traffic uses a normal connection/data session (via PLMN-A).

*Diagram

Description automatically generated*

**Fig. 5.4-3 Dual 3GPP access (VPN traffic) plus concurrent single-access data session (non-VPN)**

3. When done with the file transfer, Alice closes the VPN app, and resumes her work (to complete the afternoon deliveries).

### 5.4.4 Post-conditions

Alice is happy about the very good performance of her mobile VPN connectivity, much faster than other local cellular MNO providers previously used by her company (not partnering with MNO-SAT for the premium connectivity service).

### 5.4.5 Existing features partly or fully covering the use case functionality

A) Stage-2&3 include a feature called ATSSS (Access Traffic Steering, Switching, Splitting), e.g., ref to TS 25.301 sec. 5.3.2, which supports functionalities similar to those described in this use case, but limited to 3GPP access plus *non-3GPP* dual access.

B) Existing service requirements, e.g., from TS 22.261 sec. 6.5 and 6.18, capture some general multi-NW/RAT connectivity requirements, which do not fully cover or satisfy the specific target use case and functionalities. See some extracts (not exhaustive) listed below:

[From sec. 6.5: Efficient user plane]

A 5G system with satellite access shall be capable of supporting simultaneous use of 5G satellite access network and 5G terrestrial access networks.

[From sec. 6.18: Multi-network connectivity and service delivery across operators]

The 5G system shall enable users to obtain services from more than one network simultaneously on an on-demand basis.

For a user with a single operator subscription, the use of multiple serving networks operated by different operators shall be under the control of the home operator.

When a service is offered by multiple operators, the 5G system shall be able to maintain service continuity with minimum service interruption when the serving network is changed to a different serving network operated by a different operator.

NOTE 1: A business agreement is required between the network operators.

In the event of the same service being offered by multiple operators, unless directed by the home operator's network, the UE shall be prioritized to receive subscribed services from the home operator's network.

NOTE 2: If the service is unavailable (e.g., due to lack of network coverage) from the home operator's network, the UE may be able to receive the service from another operator's network.

NOTE 3: QoS provided by the partner operator's network for the same service will be based on the agreement between the two operators and could be different than that provided by the home operator's network.

### 5.4.6 Potential New Requirements needed to support the use case

[PR 5.4.6-001] The 5G system shall be able to support mechanisms to enable steering, split and switch of UE’s user plane traffic of one data session across two 5G networks (e.g., between NR terrestrial and satellite RATs) belonging to two different PLMN operators (one of which is the HPLMN). The following is assumed:

* HPLMN subscription is used to access both NWs, data is anchored in the HPLMN and a proper business agreement among the two PLMN operators is in place, including negotiation of traffic routing policies, e.g. based on application type;
* when multiple UE data sessions are established simultaneously (e.g. for different applications), the required mechanisms shall include the ability to use dual network connectivity for one data session, while other data sessions use single NW connection.

## 5.5 Use case on NTN based dual 3GPP access

### 5.5.1 Description

Aggregating two 3GPP access links simultaneously of which one is non-terrestrial network, to provide the following 5G service enablers is relevant especially in underserved areas, characterized by limited bandwidth or un-reliable access link:

* Extended Mobile Broadband
* Ultra Reliable service communications

As indicated in TR 38.821, a number of service scenarios as described in TS 22.261 (e.g. user in residential homes in remote areas, users on board vehicles, high speed trains, vessels or airplanes), would benefit from the combination of terrestrial and non-terrestrial access or two different non-terrestrial access (e.g. GSO and NGSO based) to meet the targeted service performances in terms of data rate and/or reliability.

In underserved areas, the bandwidth provided by a terrestrial based access (e.g. NR or LTE) may be limited at cell edge. Adding a NTN based NG-RAN will be an enable to achieve the targeted experience data rate.

Under some scenarios such as on board high speed trains, the service area may not be fully homogeneous along the rail track and multi connectivity involving NTN-based NG-RAN would enable to provide the targeted reliability.

Hence a UE may be connected and served simultaneously by:

* One NTN-based 3GPP access and one terrestrial-based 3GPP access
* One NTN-based 3GPP access (NGSO) and another NTN-based 3GPP access (GSO)
* One NTN-based 3GPP access (NGSO) via two different satellites of the same constellation

The dual access combining can occur for either the uplink or the downlink or both.

The same or different gNB could serve NR cells via the terrestrial access network and via the satellite access network (e.g. with transparent payload on board the satellite).

NTN based NG-RAN may refer to transparent payload satellites as well as regenerative payload satellites with, for example, some gNB functions on board.

In the following are illustrated:

a) Multi connectivity involving transparent payload NTN-based NG-RAN and terrestrial NG-RAN

A User Equipment is connected to a 5GCN via simultaneously a transparent NTN-based NG-RAN and a cellular NG-RAN. We assume that the NTN Gateway is located in the PLMN area of the cellular access network.

The two following cases can be considered:

Both PLMNs are managed by different operators (It is assumed that they have a business agreement among them);



Figure 5.5.1a: Multi connectivity involving transparent NTN-based NG-RAN and cellular NG-RAN different PLMN)

Both PLMNs are managed by the same operator.



Figure 5.5.1b: Multi connectivity involving transparent NTN-based NG-RAN and cellular NG-RAN (same PLMN)

b) Multi connectivity involving two transparent NTN-based NG-RAN access

This refers for example to the combination of two Transparent NTN-based NG-RANs e.g. GSO and NGSO based. This can be of interest to provide service to UEs in unserved areas. The NGSO based NG-RAN featuring relatively low latency can be used to support the delay sensitive traffic while the GSO based NG-RAN would provide additional bandwidth to meet the targeted throughput requirements. This is depicted in the figure below.



Figure 5.5.2: Multi connectivity between two transparent NTN-based NG-RAN

c) The combination of two regenerative NTN-based NG-RAN (gNB on board) via two satellites of same constellation with Inter Satellite Links in between. This is depicted in the figure below.



Figure 5.5.3: Multi connectivity between two regenerative NTN-based NG-RAN (e.g. gNB on board)

Note that

* the figure 5.x3 is for illustrative purposes. Other architecture (e.g. split NG-RAN architecture between satellite and ground) may be considered;
* SRI refers to satellite radio interface in the figure 5.x.3.

### 5.5.2 Pre-conditions

There shall be some coverage overlap between both NG-RAN access link involved.

In case of same PLMN for both access links, the UE is attached to the 5GC serving both access links.

The 5GC is aware of the respective characteristics of both access links.

In case of different PLMN for the respective access links, UE is subscribed to HPLMN and get access also to the other network through roaming agreement. Information about the respective characteristics of the access links may be exchanged between both networks.

The UE is in connected mode on at least one of the access links.

A slice can be deployed and managed over both access links.

### 5.5.3 Service Flows

The UE establish a VoIP, a video or a data service over one 3GPP access link which appears insufficient in QoS (e.g. throughput, latency, etc.). Given that another 3GPP access link is available, it is activated and combined with the first one to support the required QoS of the service.

According to the targeted QoS of the service, the user plane traffic of the connectivity can be smartly steered, splitted and switched in both directions between both 3GPP NG-RAN access links taking into account the specific performances of each access link, for example, in terms of latency, throughput, Jitter, Error rate.

The QoS requirements of the user plane traffic can be determined through specific policies associated to different data flows, or different traffic type within the same data flow.

Based on the QoS requirements (e.g. latency, throughput, Jitter, Error rate), traffic characteristics, radio links conditions and UE's moving speed, the traffic is steered/splitted across the access links. For example low latency requirement traffic will be best splitted/steered to the access link featuring the lowest latency characteristics.

In case of hand-over, temporary radio link failure or congestion on one access link, the user plane traffic can be switched to the remaining active access link. When the radio link is re-established, the user plane is again splitted/steered across both access links based on QoS.

The reported data volumes and other traffic statistics, on each access link, are used for billing purposes.

### 5.5.4 Post-conditions

Thanks to appropriate steering, splitting and switching of the user plane traffic, the dual NG-RAN access connectivity involving at least NTN can support the targeted QoS that a single access cannot support.

### 5.5.5 Existing features partly or fully covering the use case functionality

The use case can leverage and extend some of the existing service requirements, e.g. related to

* Multiple access technologies (see §6.3 of TS 22.261)
* Multi-network connectivity and service delivery across operators (see §6.18 of TS 22.261)
* NW Slices (see §6.1 of TS 22.261)
* Efficient user plane (see §6.5 of TS 22.261)

### 5.5.6 Potential New Requirements needed to support the use case

[PR 5.5.6-001] Based on operator policy, the 5G system shall be able to support UE's simultaneous data transmission pertaining to the same data session across two 3GPP 5G access networks (using at least one NR satellite RAT), and optimally distribute user traffic between the two access networks, taking into account connectivity conditions on both access networks (e.g. radio characteristics, mobility, congestion) and UE's moving speed.

[PR 5.5.6-002] When two 5G access networks are used simultaneously for the same data session, the 5G system shall be able to collect charging information, for both links simultaneously.

NOTE: in case the two 5G access networks belong to different PLMNs, single subscription and data anchoring in the HPLMN 5G CN are assumed.

## 5.6 Use case on UE using Terrestrial and Satellite Access

### 5.6.1 Description

Satellite access known as wide coverage can improve service availability in areas with poor terrestrial access network coverage or radio condition (e.g. multipath interference). For a UE in high-speed move requests real-time services, e.g. IMS voice/video meeting, it can benefit from dual connectivity with 5G system through terrestrial access and satellite access simultaneously, and obtain the continuous and reliable service with the minimum impact of terrestrial access network unavailability.

Eric is traveling to Saudi Arabia for a business trip. He will take Haramain High-speed Train, which crosses the desert for 450 km distance at a speed of 300 km/h from Makkah to Madinah [2], to visit the customer. During the journey, he has to handle urgent work via online video meetings and solve all the issues before arrival.

A train on the railway tracks

Description automatically generated

**Figure 5.6.1-1 Haramain High-speed Train [2].**

### 5.6.2 Pre-conditions

The terrestrial access network of Operator TerrA has good coverage in urban areas, suburban areas, and stopovers along the railway but limited coverage in rural areas and deserts between the stopovers. The satellite access network (e.g. LEO) of Operator SatA has covered the whole country and SatA can provide the communication service on its own.

With the agreement, TerrA can steer, switch or split the traffic of its users to the data path of SatA’s network and aggregated in TerrA’s 5GC considering the availability of SatA’s service or coverage.

Eric’s UE e.g. cell phone, or wireless network card is capable of dual 3GPP radio access including satellite access, and has the subscription of TerrA (PLMN NetA) with the service authorization.

By default, only the terrestrial access capability is activated.

### 5.6.3 Service Flows

Eric arrives at Makkah train station and enables the satellite access capability of UE when waiting for the check-in

The UE registers to NetA through terrestrial access and satellite access network with service preference e.g. instant chat with terrestrial access preferred, HD TV with satellite access preferred.

After Eric is on board, the online video meeting starts via the terrestrial access network first. During 1 hour meeting, UE’s traffic will be autonomously steered, switched or spitted between the traffic paths of terrestrial network and satellite network with the assistance of TerrA’s core network, and aggregated in TerrA’s core network to ensure the video meeting is ongoing without interruption.

When the train reaches the destination, UE will update registration to NetA once Eric disables the satellite access capability.

### 5.6.4 Post-conditions

The video meeting is finished smoothly without interruption.

The user has no awareness of traffic path steering, switching and splitting during the video meeting.

### 5.6.5 Existing features partly or fully covering use case functionality

Regarding TS 22.261, 5G system has supported UEs for multiple radio access as below.

*The 5G system shall support UEs with multiple radio and single radio capabilities.*

*Based on operator policy, the 5G system shall support steering a UE to select certain 3GPP access network(s).*

However, when considering user traffic distribution via multiple access networks, satellite access is not in the scope.

*Based on operator policy, the 5G system shall be able to provide simultaneous data transmission via different access technologies (e.g. NR, E-UTRA, non-3GPP), to access one or more 3GPP services.*

*When a UE is using two or more access technologies simultaneously, the 5G system shall be able to optimally distribute user traffic over select between access technologies in use, taking into account e.g. service, traffic characteristics, radio characteristics, and UE's moving speed.*

*The 5G system shall be able to support data transmissions optimized for different access technologies (e.g. 3GPP, non-3GPP) for UEs that are simultaneously connected to the network via different accesses.*

The service continuity is requested in TS22.261 but mainly fulfilled based on Xn-based or N2-based NG-RAN handover as TS 23.502.

*The 5G system shall support service continuity between 5G terrestrial access network and 5G satellite access networks owned by the same operator or owned by different operators having an agreement.*

### 5.6.6 Potential New Requirements needed to support the use case

[PR 5.6.6-001] With the mutual agreement, the 5G system shall support a mechanism to steer UE’s user traffic across different 3GPP access network and core network for UE with dual 3GPP access, considering service preference, traffic characteristics, radio characteristics, QoS etc.

[PR 5.6.6-002] With the mutual agreement, the 5G system shall support seamless service continuity by switching and splitting user traffic paths across different 3GPP access network and core network for UE with dual 3GPP access (e.g. NR and Satellite access) in use, based on network availability, service preference, etc.

## 5.x [Use Case Title]

### 5.x.1 Description

### 5.x.2 Pre-conditions

### 5.x.3 Service Flows

### 5.x.4 Post-conditions

### 5.x.5 Existing features partly or fully covering the use case functionality

### 5.x.6 Potential New Requirements needed to support the use case

# 6 Consolidated potential requirements

# 7 Conclusion and recommendations

Annex A (informative):  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2022-08 | SA1#99-e | S1-222210 |  |  |  | TR skeleton | 0.0.0 |
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